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COST-SIZE RELATIONSHIPS FOR CASH CROP FARMS IN IMPERIAL VALLEY, CALIFORNIA

Harold O. Carter and Gerald W. Dean

CALIFORNIA AGRICULTURAL EXPERIMENT STATION
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FORWARD AND ACKNOWLEDGMENTS

This is the second report in a series of studies in different farming areas of California emphasizing the relationship of costs to the scale of farming operations. Personal interviews with a sample of 86 growers in the Imperial Valley provide the primary basis for the analysis; the authors gratefully acknowledge the assistance and cooperation of these farmers, without whose help the study could not have been undertaken.

Assistance was also received from the Farm Advisors in Imperial County; Mr. Claude Finnell, Agricultural Commissioner, Imperial County; Dr. Chester L. Foy, Botany Department, Mr. James R. Tavernetti, Agricultural Engineering Department, and Dr. Robert Loomis, Agronomy Department, University of California, Davis. Mr. Robert Mueller, Mr. Robert Rebholtz and Mr. Knight Boyer carried out the fieldwork. Mr. Filmore Bender assisted in the statistical analysis. Dr. Dave L. Armstrong, Agricultural Economics Department, University of California, Davis, made several helpful suggestions in reviewing a preliminary draft of the manuscript.

COST-SIZE RELATIONSHIPS FOR CASH CROP FARMS IN IMPERIAL VALLEY, CALIFORNIA

by

Harold O. Carter[1] and Gerald W. Dean[1]

INTRODUCTION

This report represents the second in a series of cost-size studies focusing on different geographic areas and types of farms in California.[2] This study is restricted to an important cash crop area in Southern California--the Imperial Valley.

Description of the Area

Imperial Valley is the main agricultural area of Imperial County, bordering Mexico in the lower southeastern part of California (Figure 1). The valley is approximately 45 miles long and 30 miles wide--occupying a gross area of about 900,000 acres.[3] The land slopes northward at the rate of 4 to 10 feet per mile; the change in elevation between the lowest and highest point is over 200 feet. The entire valley drains into the Salton Sea, mainly through the channels of the New and Alamo Rivers.

The climate in Imperial Valley is arid, characterized by hot summers (daily high temperatures of over 100 degrees are common from March through October and relatively high temperatures are maintained throughout the entire year), low rainfall (an average of about 3 inches), and low humidity. The winters are sufficiently mild to permit continuous farming operations throughout the year;

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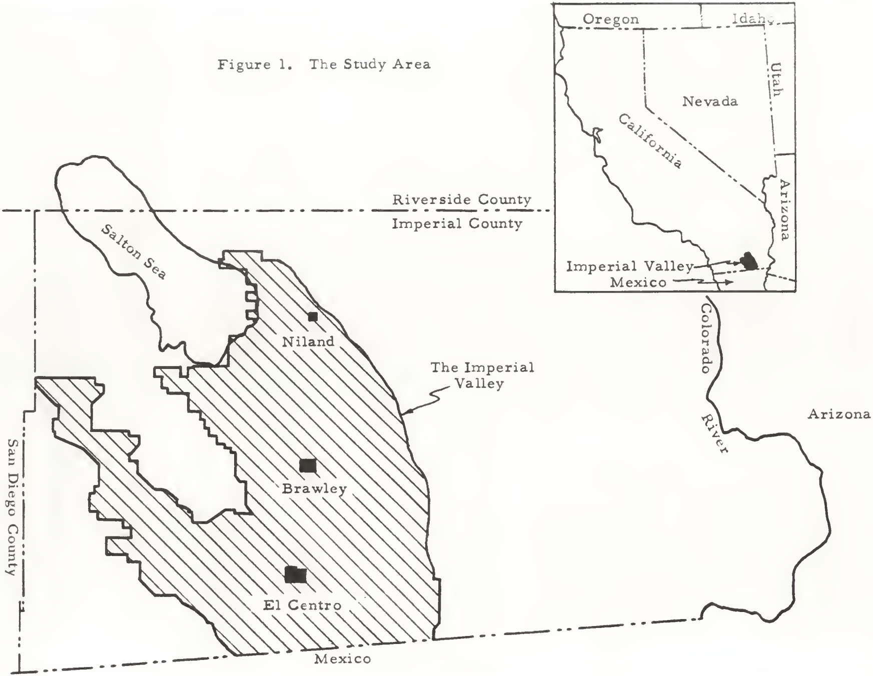
[2] See: Dean, G. W., and H. O. Carter, Cost-Size Relationships for Cash Crop Farms in Yolo County, California, Berkeley, California Agr. Expt. Sta., Giannini Foundation Mimeo. Rept. No. 238, December 1960, processed.

[3] State of California Department of Water Resources, Division of Resource Planning, Bul. No. 21. The Imperial Valley is defined as land within the boundaries of the Imperial Irrigation District.

Figure 1. The Study Area



lettuce, for example, is harvested from late December through March. The favorable climate also permits winter pasturing of cattle and sheep on alfalfa from November through February.

The soils of the Imperial Valley, mapped by two surveys,[1] are composed of two general classes of material: (1) alluvial deposits of fine textured clays, silts, and fine sands deposited by flood waters from the Colorado River, and (2) coarse textured wind-transported material. Both materials occur in strata of different textures and in various combinations; crop productivity and farming practices are influenced by the particular textural combinations encountered.

Sandier soils are generally considered to be better adapted for intensive cultivation. Sandier soils "warm up" more quick~~er~~ly in the spring than the finer textured soils, permitting earlier harvest dates on some vegetable crops. In addition, certain cultural practices and irrigating are performed more easily on the lighter soils.

Salinity is a problem affecting crop yields and practices in parts of the valley. Inadequate surface slope and the presence of relatively impervious clay layers coupled with excessive irrigation can cause a rise in the water table resulting in surface deposits of salts. This condition is alleviated in most cases by the provision of adequate drainage and a thorough leaching of the soil. Sufficient water must pass through the soil to dissolve the available salts and carry them out of the soil into the regional drainage system. The success of this leaching operation varies, depending on the salt content and physical and chemical characteristics of the soil.

Agriculture and Farm Size Trends

The growth of agriculture in the Imperial Valley has been remarkable, dating back only 60 years. Prior to June, 1901, when a small stream of water was delivered to a temporary head ditch near the international boundary, the valley was a barren desert. Within six months about 8,000 acres were being leveled for irrigation, and by 1903, 25,000 acres of land were under cultivation; primary crops were barley and wheat, with lesser acreages of oats, alfalfa, fruit, and truck crops. By 1905, this cultivated area had increased to 100,000 acres; by 1920 to over 410,000 acres; presently the net cropped land is almost 500,000 acres (see Figure 2).1/

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[1] Kocher, A. E., et al., Soil Survey of the Brawley Area, California, U. S. Department of Agriculture, Bureau of Soils, 1923, pp. 641-716; and Strahorn, A. T., et al., Soil Survey of the El Centro Area, California, U. S. Department of Agriculture, Bureau of Soils, 1922, pp. 1-59. Also, soils for the east mesa (not included in the definition of the Imperial Valley) have been mapped. See: Storie, R. Earl, et al., Soils of Imperial East Mesa, Berkeley, University of California, Division of Soils, June 1944.

Value of agricultural output is another indicator of the growth of the valley. The total value of agricultural products for 1909, as reported by the agricultural census, was slightly over 4 million dollars. The comparable value for 1959 was about 131 million dollars, indicating a 32-fold increase. In terms of value of products, Imperial County ranks fifth in the state.2/

Expansion of farm size in Imperial County parallels that evidenced in the state and the nation. In the last two decades the average size of farm in Imperial County increased nearly two and one-half times, from 155 to 381 acres.3/ For the state as a whole, farm size increased by 61 percent, from 230 to 350 acres. The change in farm size appears to be due primarily to consolidation of existing farms into larger units. For example, Table 1 shows that the percentage of farms in every size category larger than 180 acres has increased steadily since 1940. The percentage of farms over 180 acres has increased more than twofold since 1940, whereas the percentage of farms in every category smaller than 180 acres has declined over the same period.

Another indication of the scale of Imperial Valley agriculture is the percentage of the total land in the different farm size classes. For example, in 1940, 30.4 percent of the total acreage was being farmed by operations of less than 180 acres each; in 1959, only 8.8 percent of the land was being

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1/ Cosby, Stanley W., and Gordon L. Goar, Soils and Crops of the Imperial Valley, Berkeley, California Agr. Expt. Sta. Circ. 334, 1934, p. 20.

2/ Information for 1959 is from Imperial County Agricultural Commissioner's Crop Report, 1959.

3/ Preliminary Report of 1959 Census of Agriculture, Imperial County.

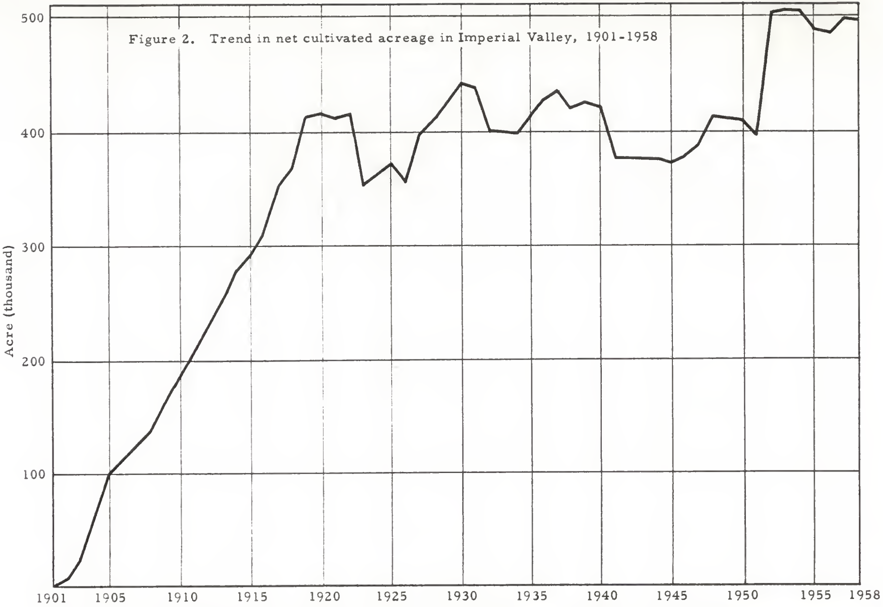

Figure 2. Trend in net cultivated acreage in Imperial Valley, 1901-1958

Source: Crop data compiled by the Imperial Valley Irrigation District and Poli, Adon, Land Ownership and Operating Tenure in Imperial Valley. USDA Bureau of Agriculture Economics, March 1942, p. 10

TABLE 1

Percentages of Total Number of Farms and Percentages of Total Acreage, by Acreage Size Classes, Imperial County

Size of class	1940		1945		1950		1954		1959	
	Farms	Acreage	Farms	Acreage	Farms	Acreage	Farms	Acreage	Farms	Acreage
	percent of total									
0-99	66.02	16.40	60.30	14.40	55.29	6.80	51.19	5.20	46.17	4.20
100-179	15.36	14.00	18.42	16.10	13.70	6.90	13.23	5.50	12.40	4.60
180-259	5.45	7.60	5.93	7.80	6.38	4.90	6.43	4.20	7.43	4.10
260-499	7.64	17.10	9.07	19.30	11.26	14.30	11.88	12.70	12.79	12.90
500-999	3.19	14.50	4.06	16.00	8.30	21.50	9.74	20.40	11.87	23.40
1,000-and over	2.34	30.40	2.22	26.40	5.07	45.60	7.53	52.00	9.34	50.80
1,000-1,999	--	--	--	--	--	--	--	--	6.51	27.20
2,000 and over	--	--	--	--	--	--	--	--	2.83	23.60
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Census of Agriculture, Imperial County, 1940, 1945, 1950, 1955, and 1959. Percentage of acreage in each class was estimated by multiplying number of farms in each class by mean of the respective size group and then dividing product by total acres farmed in Imperial County.

farmed by units of less than 180 acres. Further, in 1959, about 75 percent of the farm acreage in Imperial County was farmed by units that exceeded 500 acres.

Despite the importance of the Imperial Valley as a major agricultural producing area in California, no published empirical studies on the economics of farm size are available. In fact, only limited information is available on the economic aspects of agriculture in the valley.[1]

OBJECTIVES

The primary objective of this report is to examine costs as related to farm size for two general types of farms in the Imperial Valley: (1) field crop farms (i.e., those engaged exclusively in production of field crops such as sugar beets, cotton, barley, alfalfa, and flax) and (2) combination field crop and vegetable farms (i.e., those engaged in production of both field crops and vegetables such as lettuce and cabbage).

Cost-size relationships are studied first in terms of the cultural practices, crop combinations, and factor costs typically encountered in the valley; however, above average management and high efficiency in resource use are assumed throughout. Second, the effects of higher wage rates on the cost-size relationships are determined, based on presently used technology. Last, changes in cost economies are ascertained assuming labor-saving technology available for selected crops but presently not in widespread use.

BASIS FOR ANALYSIS OF COST ECONOMIES

The economic theory underlying an analysis of cost economies is illustrated in Figure 3, using the average-unit-cost curves of the firm.[2] The short-run

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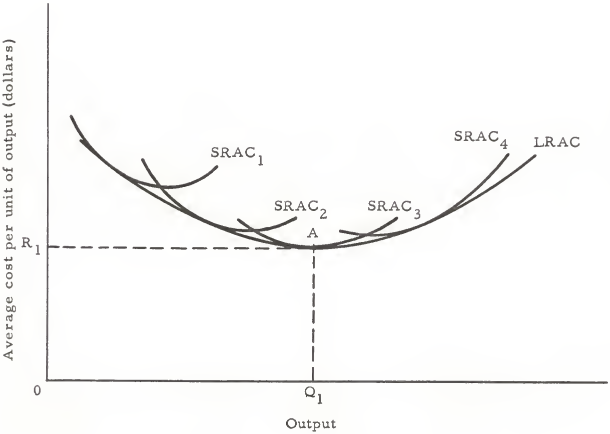
[1] A recent study by King has applicability to the cattle industry in the valley. See: King, Gordon A., "Economies of Scale in Large Commercial Feedlots." California Agr. Expt. Sta., Giannini Foundation Res. Rept. (forthcoming). Also, see: Poli, Adon, Land Ownership and Operating Tenure in Imperial Valley, U. S. Department of Agriculture, Bureau of Agr. Econ., March 1942.

[2] Concepts of economies of scale are widely discussed in economic literature. For example, for more detailed discussions see: Boulding, Kenneth E., Economic Analysis, 3rd ed., New York, Harper & Brothers Publishers, 1955, pp. 671-90; and Stigler, George J., The Theory of Price, rev. ed., New York, Macmillan Company 1952, pp. 134-147.

Figure 3. Hypothetical short-run and long-run average unit cost curves for farms of different sizes



average cost curves (SRAC) assume one or more resources to be fixed (a fixed "plant"), while other resources are variable; the long-run average cost curve (LRAC) assumes all resources are variable (including those designated as "fixed" in the short-run). In this report, machinery is designated as the resource category fixed in the short-run. Thus, $SRAC_1$ illustrates the average cost per unit of output for different levels of output, assuming a fixed set of machinery, while land and other resources are variable. Curve $SRAC_2$ is a similar average cost curve based on a different fixed machinery combination composed of more and larger pieces of equipment. Curves $SRAC_3$ and $SRAC_4$ have similar interpretations for still larger fixed machinery combinations. The short-run average cost curves have the typical theoretical "u" shape: Average costs decline with an initial expansion of output as fixed costs are spread over more units; eventually, however, average costs per unit of output level off and then rise as other inputs must be added in increasing proportions to the fixed machinery combination in order to reach greater output levels. It is emphasized that the empirical short-run curves derived later are based on high level management ability and highly efficient production practices. For the specified machinery complement, each short-run cost curve represents an approximation to the minimum cost for producing each level of output.

From the standpoint of trends in farm size and survival of the firm, the long-run average cost curve (LRAC) is probably most relevant. The LRAC curve is an "envelope" formed as a tangency to the short-run cost curves. Thus, following the argument above, the LRAC curve represents the minimum cost for producing each quantity of output. The LRAC curve can be considered as a planning curve in the sense that a farmer planning for the long-run with all resources variable could decide to operate at any point on this curve.1/ If the "u" shape is appropriate for the LRAC curve, firms would tend to limit expansion much beyond the minimum point Q_1 (unless returns were considerably above R_1, making larger output profitable). However, if the LRAC declines throughout or becomes constant beyond some point, there would be no cost disadvantage in expanding size indefinitely. Perhaps the most important factor

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1/ The LRAC curve is only an approximation to a "practical" planning curve because machinery (and possibly other inputs) are not perfectly divisable.

limiting farm size would be the risk and uncertainty inherent in farming. Expansion in size ordinarily requires borrowed capital; as more borrowed capital is employed the risk of losing equity accumulated over time increases. Thus, farmers who have achieved an efficient sized unit and satisfactory incomes may tend to "play it safe" in order to protect their current position. Also, a progressive income tax rate may reduce the incentive to expand farm size.

Multiple Products

For farms producing multiple products (the realistic situation in the Imperial Valley as well as in most agricultural areas), a total cost "envelope" surface can be visualized representing the minimum cost of producing all levels and all combinations of products. In the following empirical sections, cost curves corresponding to a fixed combination of products on the cost surface are expressed in terms of ATC (total cost ÷ total revenue) in relation to output (total revenue). However, since farmers conventionally view farm size in terms of acres operated or machinery or land investments, later empirical results are also related to these factors.1/

SOURCES OF DATA

Personal interviews with a sample of farm operators during the summer of 1960 provided the basic data for the empirical analyses in this report. These data, based on the 1959 crop year were supplemented with engineering and cost data from secondary sources, primarily publications of the California Agricultural Extension Service. California Experiment Station personnel, Imperial County farm advisors, and the Agricultural Commissioner also provided additional information helpful in the analysis.

1/ A more detailed discussion of the multiple product problem is given in: Dean and Carter, op. cit., pp. 8-13.

A stratified random sampling procedure was used in selecting the farmers to be interviewed. Initially, a list of 550 commercial farming operations was compiled which classified growers by size (total cropped acres) and by types of crops grown.[1] This list was then stratified into two main types of farms: (1) farms growing only field crops (e.g., cotton, barley, alfalfa, etc.), and (2) combination field and vegetable crop farms. The list for each type of farm was further stratified into four size classes--0-320 acres; 320-640 acres; 640-1,200 acres; and 1,200 and above. A random sample of ten growers was originally selected from each size group and type of farm. After contacting or attempting to contact this group of 80 growers it became necessary to enlarge the sample in order to complete the survey.[2]

Eligible farms for the two farm types were those meeting the following requirements:

1. Location. The ranch must be located within the boundaries of the Imperial County Irrigation District.
2. Commercial farming. The farm must be a "commercial" operation. That is, the ranch must be operated primarily for profit, which excludes "hobby" or "show" farms, experimental farms, and other similar operations. In addition, an average gross income in excess of $5,000 was required to eliminate part-time operations. Specialty operations engaging only in a single crop (e.g., lettuce or cantaloupes) were also excluded.
3. Type of farming. To qualify as a field crop farm, all of the farm gross revenue must have come from field crops.[3] The vegetable crop farms actually contained both field and vegetable crops; in most cases, vegetable crops ranged between 25 and 75 percent of total farm acreage.

Information was obtained from each farm on crop acreages, yield, machinery investment, labor use, farm expenses, and related data. Farm records and income tax summaries proved to be the main source of data for the persons interviewed.

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[1] Based on the 1959 crop year.

[2] Additional names were drawn at random until about 10 interview schedules from each size group were obtained. In some cases it was necessary to draw 20 names in order to obtain 10 schedules, due to deaths, persons discontinuing farming, refusal to cooperate, ineligible farms, and related reasons.

[3] In a few cases farms having small acreages (less than five percent) of citrus or vegetable seeds were classified as field crop farms.

In only a few cases were figures from memory alone. The final number of completed schedules by size and type of farm is summarized in Table 2. In addition, 20 combination livestock-crop farmers were interviewed, using a purposive sampling scheme. These will be analyzed in a forthcoming report.

TABLE 2

Summary of Usable Farm Schedules, by Size Group and Type of Farm, Obtained in Imperial Valley, 1960[a]

Size group (acres)		Number of usable schedules from: Field crop farms	Vegetable crop farms
I	0-320	7	14
II	320-639	9	10
III	640-1,199	10	12
IV	1,200-2,399[b]	9	9
V	2,400 +	2	3
TOTAL		37	49

[a] For the final analysis, a limited number of schedules were eliminated where the operations appeared atypical.

[b] The original size IV was post-stratified for purposes of analysis into two groups designated as sizes IV and V.

Characteristics of the Sampled Farms

Field Crop Farms

Table 3 summarizes some of the main characteristics of the sample of 37 field crop farms. Average acreage farmed was 1,077 with a range of 100 to 5,000 acres. Of the total land farmed, owned land averaged slightly greater (581 acres) than rented land (496 acres). Tracts of land farmed were often non-contiguous.

TABLE 3

Characteristics of Sample of Field Crop Farms, 1959 Crop Year[a]

Item		Unit	Mean	Range	
				low	high
Land:					
Total land		acres	1,077	100	5,000
Land owned		acres	581	0	5,000
Land rented		acres	496	0	2,690
Irrigable cropland[b]		acres	985	83	4,500
Nonirrigable cropland[c]		acres	12	0	400
Wasteland		acres	105	5	500
Crop Production:[d]					
Alfalfa hay	acreage	acres	478	84	2,560
	1959 yield	tons/acre	6.0	0.5	9.0
	"normal" yield	tons/acre	6.1	5.0	9.0
Barley.	acreage	acres	273	20	1,000
	1959 yield	tons/acre	1.8	1.0	2.3
	"normal" yield	tons/acre	1.8	1.0	2.3
Sugar beets	acreage	acres	211	30	641
	1959 yield	tons/acre	22.1	15.5	27.5
	"normal" yield	tons/acre	22.0	20.0	25.0
Cotton	acreage	acres	240	7	1,194
	1959 yield	bales/acre	2.5	1.25	3.7
	"normal" yield	bales/acre	2.6	2.0	3.75
Flax	acreage	acres	179	4	955
	1959 yield	bu/acre	42.6	25.0	57.0
	"normal" yield	bu/acre	45.1	30.0	60.0
Other crops		acreage	194	14	575
Labor:					
Total labor		dollar/year	43,801	1,563	421,200
Hired labor		dollar/year	33,563	1,200	383,200
Supervisory labor[e]		dollar/year	10,238	3,500	38,000
Machinery Investment: (mkt. value)		dollar	39,563	950	136,715
Productive Cash Expenses:[f]		dollar/year	52,944	5,120	354,200
Gross Income:[g]					
1959 prices, 1959 yields		dollar/year	197,150	18,066	1,534,520
1959 prices, "normal" yields		dollar/year	193,030	22,154	1,544,113
"normal" prices, "normal" yields		dollar/year	193,935	21,365	1,556,758

[a] Based on records from a sample of 37 field crop farms in Imperial Valley.

[b] Developed for irrigation, even if not actually irrigated in 1959.

[c] Not developed for irrigation.

[d] Acres of individual crops do not necessarily add to total cropland since some land is double cropped. "Normal" yields were estimated as the estimated average yield over the previous five years.

[e] Includes hired foreman as well as charge imputed for operator's labor.

[f] Includes custom work costs and other cash expenses directly related to output.

[g] "Normal" prices are defined as the average price over the previous five years.

The crop acreages and yields of Table 3 provided the basis for budgeting the cost curves to be presented later. Normal yields (average over the last five years) were quite similar to 1959 yields, indicating that 1959 was a fairly typical production year.

Costs of major input categories illustrate the highly commercial type of agriculture in the Imperial Valley. The average annual labor charge per farm was $43,801, but for some of the larger operations labor costs exceeded $400,000. About 75 percent of the total labor cost was hired labor, (seasonal and full-time) and about 25 percent was supervisory (hired formen and imputed charge for operator). Average machinery investment (at market value) was $39,563. Average productive cash expenses (all cash expenses other than labor, taxes, and interest) amounted to $52,944 per farm. Gross income averaged $197,150per farm based on 1959 prices and yields. Computation of gross income with (1) 1959 prices and normal yield, and (2) normal prices and yields (averages of the last five years) indicated very little difference; apparently 1959 was a fairly average year, both with respect to yields and prices for field crops.

Vegetable Crop Farms

Table 4 summarizes the major characteristics of vegetable crop farms. A vegetable crop farm as defined here is one growing both vegetables and field crops. A typical division is about 50 percent of the acreage in vegetable crops and 50 percent in field crops. The average size operation is 932 acres--slightly smaller than the average field crop farm; about 75 percent of this total is rented and 25 percent is owned. By comparison, only 46 percent of the total land was rented for the field crop farms (see Table 3).

Yields of field crops for the vegetable crop farm sample were quite similar to those for the field crop farm sample (compare Tables 3 and 4). Yields of vegetable crops were slightly down in 1959 as shown by comparing 1959 yields with normal yields. The exception was cabbage with a slight increase over normal. Of course, certain memory biases may exist in the survey method for obtaining normal yields.

TABLE 4

Characteristics of Sample of Vegetable Crop Farms, 1959 Crop Year[a]

Item	Units	Mean	Range Low	Range High
Land:				
Total land	acres	932	50	4,500
Land owned	acres	213	0	2,300
Land rented	acres	718	0	4,100
Irrigable cropland[b]	acres	839	45	4,500
Non-irrigable cropland[c]	acres	9	0	120
Wasteland	acres	84	2	450
Crop Production:[d]				
Alfalfa hay--acreage	acres	360	10	1,547
1959 yield	tons per acre	6.2	1.25	12.0
"normal" yield	tons per acre	5.9	1.0	8.0
Barley--acreage	acres	244	30	720
1959 yield	tons per acre	1.5	1	3
"normal" yield	tons per acre	1.5	1.25	2.25
Sugar beets--acreage	acres	238	40	855
1959 yield	tons per acre	22.3	18	30
"normal" yield	tons per acre	21.5	18	34
Cotton--acreage	acres	147	20	1,016
1959 yield	bales per acre	2.5	.75	3.75
"normal" yield	bales per acre	2.4	1.5	3.25
Milo--acreage	acres	180	33	500
1959 yield	tons per acre	2.0	1.0	3.0
"normal" yield	tons per acre	1.7	1.0	2.0
Lettuce--acreage	acres	358	15	1,150
1959 yield	cartons per acre	359	60	600
"normal" yield	cartons per acre	419	230	600
Cantaloupes--acreage	acres	150	30	330
1959 yield	crates per acre	134	65	250
"normal" yield	crates per acre	151	110	200
Tomatoes--acreage	acres	45	11	80
1959 yield	crates per acre	670	400	1,000
"normal" yield	crates per acre	810	500	1,000
Cabbage--acreage	acres	90	40	160
1959 yield	cartons per acre	488	222	700
"normal" yield	cartons per acre	461	180	700
Other crops--acreage	acres	97	1	1,000
Labor:				
Total labor	dollars per year	85,569	16,912	838,000
Hired labor	dollars per year	69,554	7,270	754,000
Supervisory labor[e]	dollars per year	16,935	7,200	84,000
Machinery Investment: (market value)	dollars	50,299	1,215	365,000
Productive Cash Expenses:[f]	dollars per year	89,040	7,450	471,240
Gross Income:[g]				
1959 prices, 1959 yields	dollars per year	335,635	28,724	1,158,440
1959 prices, "normal" yields	dollars per year	331,177	22,149	988,896
"normal" prices, "normal" yields	dollars per year	323,863	22,183	910,299

[a] Based on records from a sample of 49 farms in Imperial County.

[b] Developed for irrigation, even if not actually irrigated in 1959.

[c] Not developed for irrigation.

[d] Acres of individual crops do not necessarily add to total cropland since some land is double cropped. "Normal" yields were estimated as the estimated average yield over the previous five years.

[e] Includes hired foreman as well as imputed charge for operator labor.

[f] Includes only custom work costs and other cash expenses directly related to output.

[g] "Normal" prices are defined as the average price over the previous five years.

Average labor costs for vegetable crop farms in 1959 were $85,569; hired labor accounted for about 80 percent and supervisory labor for about 20 percent of the total. Average labor charges on vegetable crop farms appear to be about twice those obtained from field crop farms ($85,569 compared to $43,801); high harvest costs for vegetable crops explain a large portion of this difference.

Average machinery investment (market value) was $50,299, somewhat higher than the field crop farm sample. The large proportion of high value crops grown by these farms is emphasized by a mean gross income of $335,635 (1959 prices and yields). The gross income range of the sampled farms was large--from a low of $28,724 to a high of $1,158,440. Applying normal prices and yields changed the gross income only slightly, indicating a fairly typical year.

EMPIRICAL ANALYSIS OF COST RELATIONSHIPS

The analysis which follows provides the empirical counterpart for the theoretical short-run and long-run average cost curves discussed previously (see Figure 3). Presentation of the results is divided into two major sections: (1) cost-structure for field crop farms and (2) cost-structure for vegetable crop farms.

The general method of analysis is similar for both types of farms. On the basis of the respective samples, four machinery and equipment inventories were developed, representing typical machinery combinations for farms in each of the five acreage categories.1/ The typical machinery and equipment provide the "fixed" resource assumed in deriving short-run cost curves. Other resources

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1/ The procedure in selecting the typical machinery combination was to first determine from information obtained in the farm survey the modal power equipment by tractor type and capacity for each farm size group. A similar procedure was followed for selecting the harvesting, automotive, and land leveling equipment. Land preparation, planting, and cultivating equipment were selected for each size group consistent with the type and capacity of the power machinery. Accordingly, the machinery combinations used for the analysis represent a reasonably efficient set-up with allowances for some excess capacity necessary in unusual situations.

such as land, labor, and annual expenses were considered variable. Ultimate (or maximum) size corresponding to each short-run curve was determined by the capacity (defined later) of the machinery and equipment. A long-run average cost curve was then drawn as an envelope to the short-run average cost curves.

Field Crop Farms

Table 5 shows the typical machinery and equipment combinations assumed for each of the five field crop size groups. Complete custom or contract operations are used for farms less than 320 acres. Budgeted costs for these smaller farms indicated that custom hire, which is available for most cultural and harvest operations, is less costly than owning equipment. Several farms in the 0-320 acre group were operated almost exclusively with custom work in 1959. As farm size expands, the primary machine investments are for power and harvesting equipment. Size II farms (320-640 acres) typically own a single medium horsepower crawler tractor and three wheel tractors; Size III farms (640-1,200 acres) own two medium-sized crawlers and four wheel tractors. Further increases in both tractor numbers and horsepower are evident for Size IV and V farms.

Harvesting operations on field crop farms are performed by a combination of owned and custom work depending on the crop. For example, hay harvest (mowing, raking, and baling) is generally performed with owned equipment. On the other hand, combining grain and flax is typically a contracted operation for large and small farms. Sugar beet digging is generally contracted on most farms of less than 1,200 acres.

Although the farm survey indicated that some field crop farms specialize in a single crop (e.g., alfalfa) the more typical situation is a multiple crop farm. Large variations between some farms in the proportions of different crops grown was apparent; nonetheless, a few general cropping patterns prevail. In the following analysis for field crop farms, two different cropping systems are assumed; these are designated as FC-I and FC-II in Table 6. Cropping system FC-I includes a higher percentage of high value crops (i.e., cotton and sugar

TABLE 5

Typical Machinery Combinations for Field Crop Farms of Various Size, Imperial Valley, 1959

Type of machine	Machinery combination for farm sizes[a/] II (320-640 acres)	III (640-1,200 acres)	IV (1,200-2,400 acres)	V (2,400 acres and more)
Automotive equipment:				
Pickups	1	3	4	5
Trucks-flatbeds	1	1	2	2
Trailers	1	1	3	3
Wagons	1	2	2	2
Implement carryalls	0	1	1	2
Power equipment:				
Crawler tractors 50 CDB HP	0	0	1	2
75 CDB HP	1	2	1	3
100 CDB HP	0	0	2	2
Wheel tractors 30 CDB HP	2	2	3	5
40 CDB HP	1	2	3	4
Land preparation equipment:				
Chisel	1	1	2	2
Disc up to 8'	1	0	0	0
8 to 10'	0	0	1	1
10 to 14'	1	2	1	1
14 to 16'	0	0	1	2
Harrows - spike 12'	1	1	2	2
Harrows - spring 12'	1	1	1	1
Rollers - 12'	1	1	1	2
Ridgers	0	1	1	1
Tool bars Crawler T.	0	0	1	1
Wheel T.	2	3	4	4
Ditcher	1	1	1	1
Plow 3-bottom	0	0	1	1
Planting and cultivating equipment:				
Planters	1	2	2	3
Grain drills	1	2	2	3
Cultivators- 2 row	2	0	0	0
4 row	0	2	3	4
Sprayer - 300 gal.	1	1	1	1
Harvesting equipment:				
Beet digger - 2 row	0	0	1	2
Mowers	1	2	2	3
Rakes	1	2	2	3
Hay balers	1	1	2	3
Cotton pickers	0	1	2	3
Bale loaders	1	1	2	2
Land leveling equipment:				
Landplanes - 10' x 40'	1	1	0	0
12' x 60'	0	0	1	2
Drag or float	1	1	1	1
Scraper	1	1	2	2
Grader	0	0	1	1

[a/] It is assumed that for Size I (0-320 acres) farms all machine operations are hired at prevailing contract rates.

Source: Sample of 37 field crop farms; Imperial Valley, 1959 crop year.

TABLE 6

Cropping System Data Assumed for Field Crop Farms

					Field Crop I			Field Crop II		
Crop	Unit	Yield per acre[a]	Price per unit[b]	Total revenue per acre	Percentage of acreage in rotation[c]	Owner-operated total revenue per acre of rotation	Share-renter total revenue per acre of rotation[d]	Percentage of acreage in rotation[c]	Owner-operated total revenue per acre of rotation	Share-renter total revenue per acre of rotation[d]
			dollars		percent	dollars		percent	dollars	
Alfalfa	tons	6.00	26.00	164.00[e]	40	65.60	49.20	40	65.60	49.20
Barley	tons	1.75	45.00	78.75[f]	20	15.75	11.81	30	23.62	17.72
Flax	bu.	45.00	2.90	136.50	10	13.65	10.24	10	13.65	10.24
Sugar beets[g]	tons	22.00	14.39	316.58	15	47.49	37.99	10	31.66	25.33
Cotton	bales	2.25	158.40	395.70[i]	15	59.36	47.49	10	39.57	31.66
Cottonseed[h]	lbs.	1,917.00	0.0205							
All crops		--	--		100	201.85	156.73	100	174.10	134.15

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a/ For a complete list of yield assumption, see Appendix Table A-3.

b/ For a complete list of price assumptions used for all crops considered in the analysis, see Appendix Table A-2.

c/ Over-all acreages based on sample of farms and adjusted to reflect a feasible individual farm rotation.

d/ Share-renter's total revenue based on the typical share leasing agreements in the Imperial Valley (see Appendix Table A-1).

e/ Includes 1 pasturing at $8.00.

f/ Includes $6.00 per acre received for straw.

g/ 16.2 percent sugar content.

h/ Yield based on 852 lbs. of cottonseed per bale of cotton.

i/ Includes $39.30 per acre for cottonseed.

beets) than FC-II. System FC-II appears to be more representative of the young or new farmers who are likely to have relatively smaller cotton or sugar beet acreages than well-established operators. In the following analysis, constant yields per acre and constant prices are assumed for all farm sizes.[1/]

Cost Curves for Machinery (Cropping System FC-I)

Machinery and equipment is the major investment item often mentioned as a source of cost economies for large operations. Because of their importance, machinery costs are first examined separately. Later they are incorporated with other costs to analyze cost-size relationships for the whole operation.

Figure 4 shows machinery costs (machinery and associated labor) for each of the five "fixed" machinery combinations. Each cost curve is extended to full capacity of the machinery complement.[2/] Fixed costs for owned machinery include annual depreciation, six percent interest on the average investment, insurance, and personal property taxes. Variable costs of machinery operations include fuel, oil, lubrication, tires, repairs, and custom machine hire. Also included in variable costs are costs of the labor required to operate the machinery and equipment (e.g., tractor driving costs at $1.60 per hour including FICA and Workmans Compensation). Total machine costs per acre (cropping system

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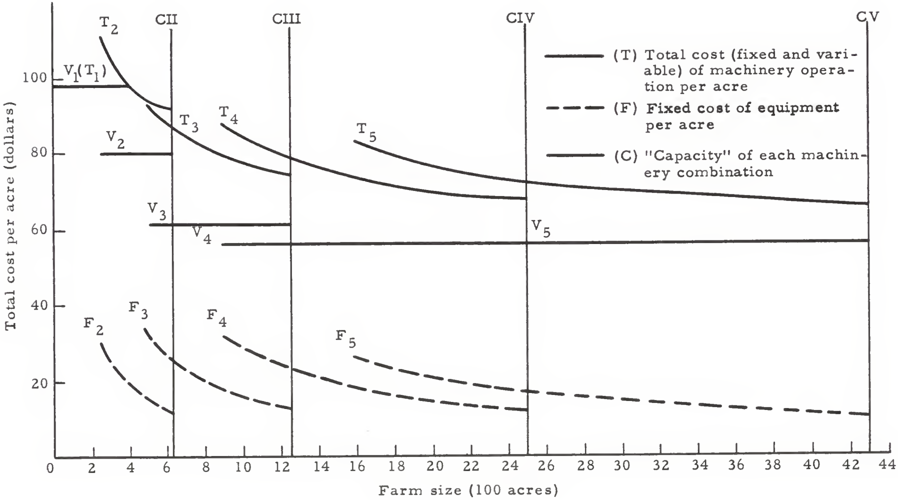
[1/] Survey data indicated no appreciable difference in yield per acre among size groups. Also, no evidence was available to suggest different product prices received on farms of different sizes.

[2/] Machinery capacity for each size category is determined as follows: Tracklayer and wheel tractor power available by time periods were determined (see Table A-4) making allowances for "down-time." Historical rainfall data were used to estimate the total number of days per month available, on the average, for field operations. A ten-hour day was assumed excluding Sundays and holidays. From these calculations estimates were obtained of the maximum number of acres of a specified cropping system that can be operated for each machinery combination. Machine costs and engineering data for budgeting purposes were obtained from survey data and Reed, A. D., Machine Costs and Related Data, California Agr. Ext. Serv., Davis, 1959. These sources are supplemented by other miscellaneous publications, inquiries of machinery dealers and custom machine operators in the Imperial Valley.

Figure 4. Machinery operation costs per acre (including labor) for each machinery combination, used at different acreage levels, (FC-I cropping system)



FC-I, Table 6) for each machine combination are designated as T_1, T_2, T_3, T_4, and T_5 in Figure 4. With the exception of T_1, total machine costs decline continuously up to "capacity" use of the respective machine combination. Curve T_1 shows constant machine costs per acre because all operations are custom hired. The total cost curves for each machine size were obtained by summing the respective variable costs (V_1, V_2, etc.) and the fixed costs (F_2, F_3, etc.).

Figure 4 indicates that total machinery costs per acre are $98 if all work is done on a custom basis (T_1). Machinery combination II (T_2) shows costs per acre of $110 at 250 acres but declining sharply to $91 at "capacity" of about 625 acres. It appears that 400 acres is the approximate "breaking point" where it is more efficient to change from contracting to owning major power equipment. Of course, the implicit assumption here is that competent custom machine operators are available when needed--a fairly plausible assumption for many operations in the study area. Total costs per acre for the Size III machinery combination (T_3) show a substantial cost reduction--from $93 at 500 acres to $74 at 1,250 acres. Total machine costs per acre for larger machine combinations decline only slightly: At 2,500 acres, total machinery operation costs are $67 per acre ($T_4$) while at 4,500 acres, Size V machinery costs are $65 per acre ($T_5$). This analysis indicates that ownership and operation of farm machinery is a definite source of economies of scale in field crop farming.

Cost Curves for All Inputs (Owner-Operator--Cropping System FC-I)

In addition to machinery costs, other costs necessary to arrive at total costs per acre (or per dollar of output) for the crop rotation include: (1) cultural costs (e.g., seed, fertilizer, water, sprays, dusts, electricity, and similar expenses), (2) labor costs, such as field labor (at 80 cents per hour), bookkeeper (at $400 per month and foremen at $600 per month),[1] (3) interest on the land investment of $33 ($550 land at 6 percent), and (4) land taxes of $10 per acre. Accordingly, total cost as calculated incorporates all fixed and variable costs,[1] including a market rate of return on invested capital.

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[1] Since foreman and bookkeeper labor cannot be associated directly with individual crop costs, they are treated as a fixed cost for the different size groups as shown in Table 7.

TABLE 7

Fixed Labor Charges Assumed for Analysis,
Imperial Valley Farms

Farm size[a]	Bookkeepers		Foremen		Total
	Number	Yearly wages	Number	Yearly wages	fixed labor
acres		dollars		dollars	
III 640-1,200	1/4	1,200	1	7,200	8,400
IV 1,200-2,400	1/2	2,400	1	7,200	9,600
V 2,400 +	1	4,800	2	14,400	19,200

[a] Survey data indicated that operators of farms of less than 640 acres generally acted as their own foreman and bookkeeper.

Figure 5 illustrates the resulting short-run total costs curves (I, II, III, IV, and V) for each machinery group and the envelope or planning curve (PC-I). Costs are expressed in two ways: Total costs per dollar of total revenue can be read off the left vertical scale, whereas total cost per acre can be read off the right vertical scale. Output is measured in terms of total revenue (upper horizontal scale) and in terms of acres (lower horizontal scale).[2] Line RR' at $202 (on the right vertical scale) represents the average gross income per acre from the specified cropping system. The corresponding measure on the left vertical scale is 1.0, indicating the "break-even" point (i.e., total costs equal total revenue).

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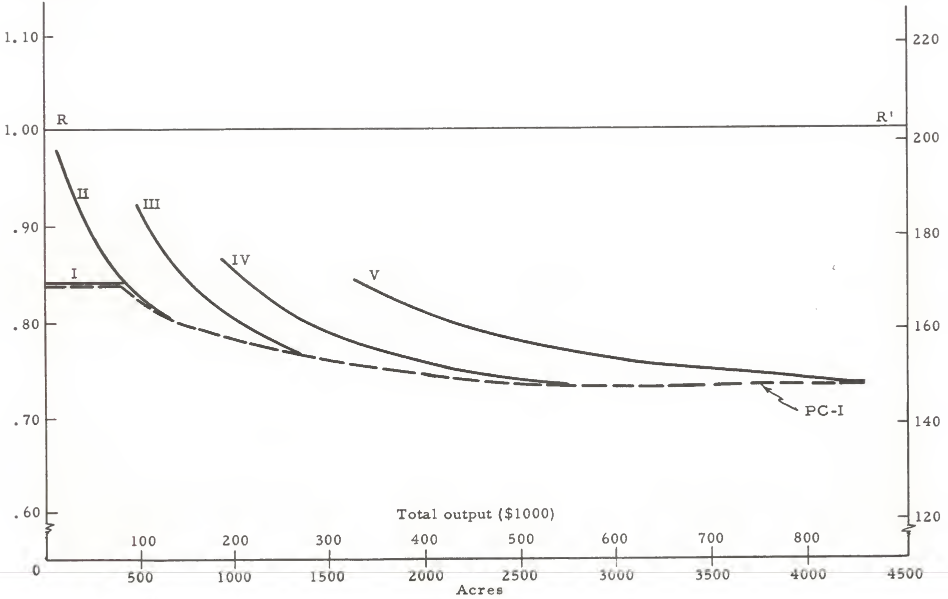
[1] See Appendix Table A-5 for a summary of variable costs and returns per acre for each crop alternative by machines size group.

[2] It should be noted that product prices changes do not affect the shape or level of the curve if reference is made to costs per acre (right hand scale). However, the total revenue per acre (line RR') and the positions of the cost curves themselves would change when measured in terms of total cost per dollar of revenue (left hand scale).

Figure 5. Average total cost curves for each machinery combination and envelope or planning curve (owner operator FC-I cropping system)



One point regarding Figure 5 and later analysis should be emphasized at the outset: The long-run average cost curves (planning curves such as PC-I in Figure 5) follow short-run cost curve I on small farms, and thereby assume that contract work is readily available for all farming operations. The reasonableness of this assumption is emphasized by the facts that (1) several commercial operators are available in Imperial Valley who do contract work for all types of farming operations--contract work is their specialized business; and (2) several small farms were contacted which owned no machinery or equipment, but relied exclusively on custom operators. Despite the general availability of custom operators, there may be times, places or operations for which contracting is impossible. In those cases, the planning curves for the small operator would likely follow short-run cost curve II, based entirely on owned equipment.

The planning curve (PC-I) in Figure 5 declines steadily to about 1,500-2,000 acres (total revenue of $300,000-$400,000) and declines only slightly thereafter. For each size group, minimum cost per dollar of total revenue (or per acre) is achieved with maximum capacity use of fixed resources (i.e., machinery and managerial labor). For example, short-run cost curve II shows per acre costs declining from $192 at 125 acres to $163 at "capacity" of 625 acres. Similarly, curve III shows per acre costs declining from $187 at 500 acres to $157 at "capacity" of 1,250 acres. Cost curve IV declines to $147 per acre at 2,800 acres, which is identical to the cost per acre shown for Size V at 4,500 acres. On a cost per dollar of output basis, PC-I declines from about 84 cents at low output levels to about 73 cents for output levels in excess of $500,000. Thus, the net returns for the owner (total revenue less all costs as defined above) before income tax over the corresponding range in output varies from 16 cents to 27 cents per dollar of output.

These cost curves emphasize three points: (1) significant cost advantages accrue to field crop farm operations up to a size of about 1,500-2,000 acres; thereafter, the costs per unit decline only slightly and eventually level out, (2) if farms that are highly mechanized and otherwise set up to operate large acreages under-utilize this capacity, they may have higher unit costs than smaller operations more fully utilizing their fixed resources, and (3) farms of any size operated efficiently could make reasonable profits under the conditions prevailing in 1959.

Cost Curves for all Inputs (Owner-Operator--Cropping System FC-II)

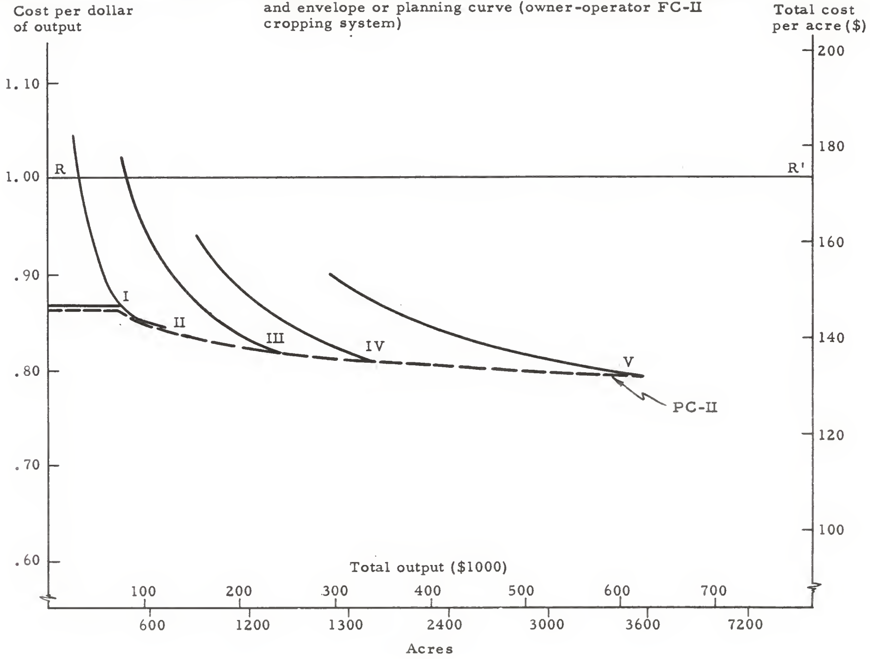
Figure 6 shows cost curves similar to those in Figure 5, but assuming the less intensive cropping system FC-II (compare FC-I with FC-II in Table 6). As a result of less intensive crops, total costs per dollar of output are higher at all output levels. Moreover, less cost difference is indicated between small and large operations. The long-run average total cost curve (PC-II in Figure 6) indicates that the lowest per unit cost is about 87 cents per dollar of output for small farms and then declines gradually to about 79 cents per dollar of output at an output level of about $625,000 (or 3,600 acres). Over the comparable range of output (total revenue), total costs for the more intensive cropping system (FC-I) diminished from 84 cents to 73 cents per dollar of output.1/

Assuming that the less intensive cropping system FC-II is representative of young or new field crop farmers in Imperial Valley, the analysis emphasizes the disadvantageous position of this group as compared to established operators with more intensive cropping systems. For example, the operator with the less intensive crops requires greater acreage in order to achieve the same level of net income. In addition, he is probably more vulnerable to the so-called "price-cost squeeze" in that the two most intensive crops, cotton and sugar beets, have been government controlled and therefore probably have greater income stability than the less intensive crops.

It is emphasized again that cost and revenue functions of Figures 5 and 6 are based on above average farming efficiency, normal yields, and prices. No economies are assumed in buying resources or in marketing products in quantity. Also, no diseconomies are assumed as size increases, such as might result from less efficient labor use on the larger farms.

1/ These comparisons are made on cost per dollar of output basis because a comparison of the costs for the two cropping systems only in terms of per acre costs can be somewhat misleading. At 640 acres, for example, the lowest cost per acre is about $148 for the less intensive cropping system (FC-II) compared to $164 for FC-I. On a cost per dollar of output basis, however, the corresponding costs are 85 cents and 81 cents, respectively, because of the higher revenue per acre from FC-I. Thus, comparisons of cost are more meaningful when associated with a common output measure (e.g., revenue) rather than with an input measure (e.g., acres) which may have a changing revenue per unit of input as level of input changes.

Figure 6. Average total cost curves for each machinery combination and envelope or planning curve (owner-operator FC-II cropping system)



Effects of Wage Increases on Total Cost Curves (Cropping System FC-I)

Rising agricultural labor costs in the Imperial Valley and other agricultural areas in California are a problem of increasing importance. Presently, farmers in California are facing the possibility of some minimum wage for agriculture. What would be the effect of a minimum wage of $1.25 per hour or higher on net returns for farms in the Imperial Valley? What labor-saving adjustment in technology might be made to offset these wage increases? How will these possible adjustments affect the net returns of Imperial Valley farms? In this section, the effects on costs and returns of two arbitrarily selected wage increases are examined, first assuming present technology and secondly, assuming the adoption of labor-saving technology on selected crops.

Two levels of wage increases were selected, not as predictions of future wages, but rather as benchmarks in illustrating the effect of wages on costs. In one case the costs of both skilled and unskilled labor were increased by 50 percent. Thus, skilled labor costs (tractor drivers, combine operator drivers, etc.) were increased from $1.60 to $2.40 per hour while unskilled labor costs (irrigating, hoeing, thinning, etc.) were increased from $0.80 to $1.20 per hour. In the other situation, costs of both skilled and unskilled labor were increased 100 percent (i.e., from $1.60 to $3.20 per hour for skilled labor and $0.80 to $1.60 per hour for unskilled labor). Managerial labor (foremen) charges were assumed to increase only to the extent necessary to maintain the present margin between the two types of work rather than increasing them by the same percentage as for hourly workers. For example, tractor driver wages presently at $1.60 per hour are roughly equivalent to $400 per month. Foremen's wages presently are assumed to be $600 per month. Hence, when hourly wages are increased by 50 percent to $600 per month, foremen's wages are increased to $800 per month--maintaining the $200 per month spread in wages between the group. Likewise, in the situation where hourly wages are increased by 100 percent (roughly equivalent to $800 per month), foremen's wages are increased to $1,000 per month. Since bookkeepers' earnings are presently equivalent to those of tractor drivers (on a monthly basis) it was assumed that they increase in the same proportion.

Table 8 shows the effects of increased wages on the total variable costs for producing selected crops on Size III farms. Labor costs (skilled and unskilled)

TABLE 8

Total Variable Cost for Various Crops Showing Labor Costs and Changes in Total Variable Cost as Labor Costs Increase for a Size III Field Crop Farm (640-1,200 acres)

Crop	Total variable cost	Present condition						Possible future conditions			
		Hired labor costs c/			Labor cost as a percent of total variable cost			50 percent increase in cost of labor		100 percent increase in cost of labor	
		Skilled a/	Unskilled b/	Total	Skilled	Unskilled	Total	Total variable cost	Percentage increase in TVC	Total variable cost	Percentage increase in TVC
	dollars				percent			dollars	percent	dollars	percent
	1	2	3	4	5	6	7	8	9	10	11
Alfalfa	67.83	17.97	3.84	21.81	26.5	5.7	32.2	78.74	16.1	89.64	32.2
Cotton	174.71	15.20	27.68	42.88	8.7	15.8	24.5	196.15	12.3	217.59	24.5
Sugar beets	175.98	16.48	41.92	58.40	9.4	23.8	33.2	205.18	16.6	234.38	33.2
Flax	65.80	5.92	1.92	7.84	9.0	2.9	11.9	69.72	6.0	73.64	11.9
Barley	41.29	4.48	1.68	6.16	10.8	4.1	14.9	44.37	7.5	47.45	14.9
Milo	40.07	4.00	1.20	5.20	10.0	3.0	13.0	42.67	6.5	45.27	13.0
Lettuce	452.19	12.80	152.08	164.88	2.8	33.7	36.5	534.63	18.2	617.07	36.5
Cabbage	575.44	14.72	177.48	192.20	2.6	30.8	33.4	671.54	16.7	767.64	33.4
Cantaloupes	562.65	14.56	142.04	156.60	2.6	25.2	27.8	640.95	13.9	719.25	27.8

a/ Skilled labor includes tractor driving, truck driving, and similar tasks and is charged at $1.60 per hour.

b/ Unskilled labor includes irrigating, hoeing, thinning, and related field work and is charged at $0.80 per hour.

c/ Excludes foremen and bookkeeper labor costs.

are shown as a percent of total variable costs under present conditions and for the two labor cost increases noted above. However, labor costs as shown in Table 8 exclude any foremen or bookkeeping labor since the latter are considered fixed costs for the different size groups. Some vegetable crops are also included in Table 8 and are used in the analysis of vegetable crop farms in a latter section.

As expected, labor changes are lowest for the mechanized crops such as milo, barley, and flax, accounting for only 12 to 15 percent of total variable costs (TVC). For the other crops, labor charges account for one-fourth to one-third of TVC. It is somewhat surprising that labor charges are 32.2 percent of TVC for alfalfa--an almost completely mechanized crop. However, skilled labor (mainly tractor driving for cutting, raking, and baling) comprises the major labor costs for alfalfa. Among the field crops, alfalfa, cotton, and sugar beets show the greatest absolute and percentage increase in TVC resulting from increased labor costs.

It appears likely that farmers will make adjustments in their current production practices to help offset the effects of rising labor costs. Of the field crops, cotton and sugar beets appear to offer the greatest potential for reducing labor costs since both crops depend heavily on unskilled labor (unskilled labor accounts for about 16 percent of TVC for cotton and about 24 percent of TVC for sugar beets). Discussions with University specialists working closely with the various production phases of these two crops revealed that certain labor-saving practices are available and profitable under some conditions. Accordingly, an alternative set of practices, labeled as "possible technology," was formulated and related costs estimated. A summary of costs and returns with "present" and "possible" technology for cotton and sugar beets on a Size III farm is given in Table 9.1/

A substantial reduction in man hours is accomplished by replacing hand hoeing and thinning with the use of weed sprays, flame cultivation, and

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1/ Similar calculations derived for the other size farms are not presented individually but are incorporated into the following analysis considering the impact of wage increases on total farm costs.

TABLE 9

A Comparison of Costs and Returns for Cotton and Sugar Beets with Present and Possible Technology[a]
(Size III Farm)

	Cotton		Sugar beets	
	Present tech.[b]	Possible tech.[c]	Present tech.[d]	Possible tech.[e]
Total revenue	$395.70	$376.31	$316.58	$284.92
Total variable costs	174.71	173.92	175.98	161.32
Total labor costs	42.88	29.60	58.40	35.36
Total man hours	44.10	23.30	62.70	33.30
Skilled labor cost	15.20	21.92	16.48	17.44
Skilled man hours	9.50	13.70	10.30	10.90
Unskilled labor cost	27.68	7.68	41.92	17.92
Unskilled man hours	34.60	9.60	52.40	22.40
Net revenue	220.99	202.39	140.60	123.60
Assumed yield	2.25 bales	2.14 bales[f]	22 tons	19.80 tons[g]

[a] See related discussion for assumption and source involved in the above calculations.

[b] Present practices include hand hoeing and thinning and machine picking.

[c] Hand hoeing and thinning are replaced with (1) 3 applications of a weed oil spray (carrot weed oil) when plant is between 2 and 6 inches high, (2) 5 applications of flame thrower from the time plant is 8 inches high until lay-by time, (3) mechanical thinning with 4 row thinners.

[d] Present practices include hand hoeing and thinning.

[e] Thinning and some hand hoeing was replaced with (1) a pre-plant application of endothal and (2) machine thinning.

[f] Yield was assumed to be reduced by 5 percent with no effect on the grade of cotton.

[g] Yield was assumed to be reduced by 10 percent with no effect on quality.

mechanical thinning.[1] Total man hours per acre saved amount to 20.8 (a reduction in unskilled labor needs of 25 hours with an increase of 4.2 hours of skilled labor). Assuming a reduction in cotton yield of 5 percent (with no quality change) for the "possible technology" situation results in a decrease in total revenue of $19.39 per acre. At the same time, total labor costs (assuming present wages) are reduced from $42.88 to $29.60 per acre but costs for materials are increased by $12.49 (e.g., spray material). Hence, net returns for cotton are decreased by $18.60 per acre with the labor-saving technology assuming present wages.

The main labor requirements for sugar beets also are for hoeing and thinning. The use of a pre-emergence spray and a mechanical thinner substitutes for some hand labor.[2] Total man hours are reduced from 62.7 to 33.3 per acre with these changes (Table 9). Labor costs estimated with present technology or practices are $58.40 per acre compared to $35.66 with "possible technology"; skilled labor cost increases slightly ($17.44 compared to $16.48) but unskilled labor cost declines substantially ($41.92 compared to $17.92). The decline of unskilled labor needs has importance not only with respect to net return but also in terms of the uncertainty of a continuing supply of unskilled labor in the Imperial Valley.

An indirect cost involved in the substitution of machinery for labor is the reduction in sugar beet yield. Estimates based on preliminary work range from a 15 percent yield reduction to negligible losses; for this study it is assumed that a 10 percent reduction in yield is associated with "possible technology." Accordingly, the net return for sugar beets using "possible" practices was estimated at $123.60 per acre compared to $140.60 with "present technology."

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[1] Information was obtained from Dr. Chester L. Foy, Botany Department, and Mr. James R. Tavernetti, Agricultural Engineering Department. The following sources were also consulted: Tavernetti, J. R.,and H. F. Miller, Jr., Studies in Mechanization of Cotton Farming in California, Calif. Exp. Sta. Bul. 747, November 1954; Weed Control Recommendations, 1960, University of Calif. Agr. Ext. Serv.; Mechanized Production of Cotton, University of Arkansas College of Agr., Agr. Exp. Sta. Rept. Series No. 22, February 1951; Mechanization of Cotton Production, Southern Cooperative Series, Bul. No. 33, June 1953.

[2] Information was obtained from Chester L. Foy, Botany Department, and Robert Loomis, Agronomy . Also see: Foy, Chester L., "Weed Control." The California Sugar Beet, 1959, p. 54; Weed Control Recommendations, 1960, Univ. of California, Agr. Ext. Serv.; The California Sugar Beet, 1958, 1959, and 1960 issues.

Table 10 shows a comparison of the investment in machinery for "present" and "possible" technology situations. Although the investments in labor-saving machinery vary by size groups, the number of machines required to complete the operations increases almost proportionately to acreage. The increase in capital investment to utilize the labor-saving practices is relatively small since thinners and oil rigs can be used for both cotton and sugar beets.

TABLE 10

Machinery Investments by Size Groups,
with Present and Possible Technology
(Field Crop Farms)

Size group	Total machinery investment	
	Present technology[a]	Possible technology[b]
acres	dollars	
II 320-640	59,080	62,080
III 640-1,200	113,280	117,480
IV 1,200-2,400	207,745	214,045
V 2,400 +	306,215	314,615

[a] Combination of equipment for each size group is given in Table 5. Investment costs are obtained from Reed, A. D., Machinery Costs and Related Data, May 1959, and from farm machinery dealers.

[b] Additional machinery required include:

Implement	No. in each size group			
	II	III	IV	V
4-row thinners	1	2	3	4
cotton flammers	1	2	3	4
oil rigs	1	2	3	4

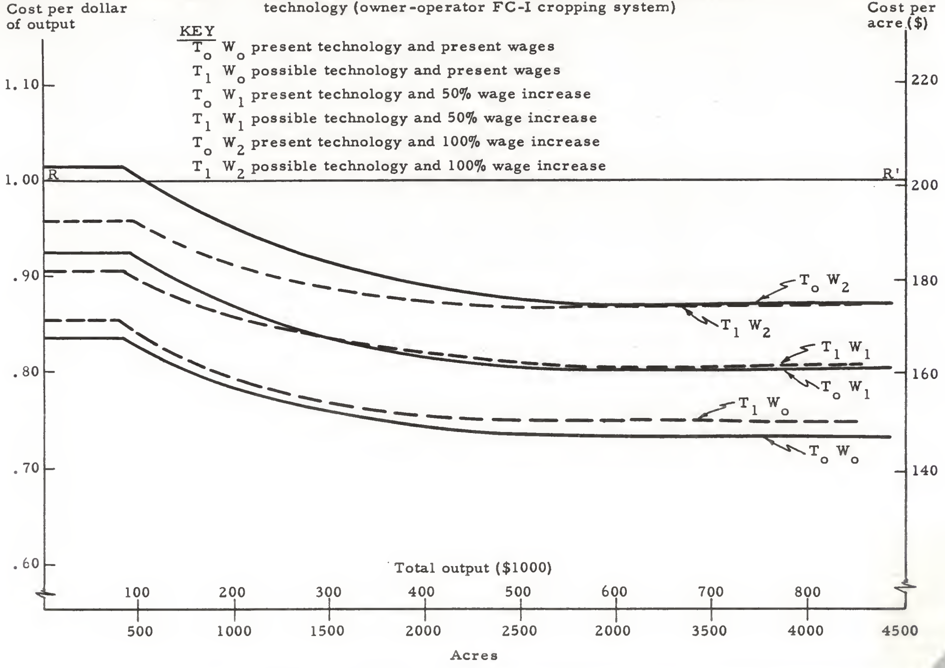
The above cost estimates for two levels of mechanization emphasize that the feasibility of particular changes must be determined on the basis of the prevailing costs and conditions. The cost comparisons made for sugar beets and cotton are based on definite assumptions regarding the effects on yield from particular practices as well as the costs associated with the new practices. Since these practices have been used little commercially it is not possible to judge accurately their reliability. Undoubtedly, individual costs and yields could vary widely depending on the skill and experience of persons operating flame throwers, mechanical thinners, and other equipment. Costs alone, however, are not the only criterion for making shifts toward increased mechanization. Other considerations are the availability of a continuing supply of competent field workers.

Effects of Wage Increases on Total Cost Curves

The proceeding section has (1) indicated the effect on individual crop production costs associated with increased labor charges and (2) compared sugar beet and cotton production costs under present and possible technology. An attempt is now made to incorporate these alternative wage and technology conditions into the analysis in order to determine the impact on total costs of the operation. Specifically, in Figure 7, comparison of planning curves (long-run average cost curves) are made for six alternative combinations of wages and technology assuming the FC-I cropping system (see Table 6). For each of the curves, T designates technology with the subscript o and 1 referring to "present" and "possible", respectively. Likewise, W_o, W_1 and W_2 refer to present wages, a 50 percent wage increase, and a 100 percent wage increase, respectively. For example, the planning curve designated as $T_o W_o$ (identical to PC-I shown in Figure 5) shows total costs per dollar of output (or per acre on right hand scale) with present technology and wages. Curve $T_1 W_o$ is identical to $T_o W_o$ with the exception that costs for sugar beets and cotton are based on the "possible" technology (see Table 9).

A comparison of curves $T_1 W_o$ and $T_o W_o$ indicates that, with present wages, current technology provides a slight cost advantage over the "possible" technology situation. The vertical difference between the two curves ($T_1 W_o$ and

Figure 7. Planning curves for three wage levels, present and possible technology (owner-operator FC-I cropping system)



$T_1 W_o$) is only about 1.5 cents per dollar of total revenue (or about $3.00 per acre of the cropping system).

A 50 percent increase in wages with current practices results in a substantial increase (about 10 percent) in average total costs as illustrated by comparing $T_o W_o$ and $T_o W_1$. At the higher wage rate, costs are lessened slightly with the use of labor-saving technology (compare $T_1 W_1$ and $T_o W_1$) for operations up to 600-700 acres but thereafter the differential is negligible. Wage increases have a greater effect on costs for Size I and II farms since typical practices for Size I and II farms include two hand pickings of cotton whereas on farm sizes III, IV, and V the typical practice is one machine picking and one hand picking.

Doubling the wage rate (compare $T_o W_2$ and $T_o W_o$) results in about a 20 percent increase in average total costs. In this case, efficiently operated field crop farms with an output of less than $110,000 (or 550 acres) would be operating at a loss. Although this does not necessarily imply a loss in cash income, it means that the operator is accepting returns on his invested capital and other resources which are below competitive market rates. However, use of the labor-saving technology for sugar beets and cotton at this high wage level reduces total costs quite substantially (compare $T_o W_2$ and $T_1 W_2$); at low output levels the cost differential is about $11 per acre but declines for larger sized operations for the reasons noted above.

In summary, these results indicate that an increase in labor costs in the Imperial Valley would substantially raise total costs of field crop farms (e.g., 50 percent wage increase increases average total costs by about 10 percent) but does not appear to appreciably change the relative cost advantage of larger farms. Substitution of possible labor-saving technology in the production of labor intensive crops such as sugar beets and cotton can offset some of the wage increases.

Cost Structures for Share-Rented Farms (Cropping System FC-I)

The farm survey in the Imperial Valley revealed that share renting all or part of the total acreage operated is a common practice. The following analysis presents estimates of long-run cost curves (planning curves) for farms operating exclusively on a share-rental basis. The basic data and procedures followed for deriving cost curves are identical to those employed in previous sections except that (1) land taxes and interest on land investment are excluded from total costs and (2) crop income represents only the share received by the renter.[1]

Figure 8 presents planning curves derived with the same three levels of labor costs combined with both "present" and "possible" technology as discussed above for owner-operated farms. A comparison of the respective planning curves in Figures 7 and 8 indicates that costs per dollar of output for the renter are lower and decline more rapidly than for the owner-operators. Total costs per dollar of output (total revenue) for rented operations are about 7 cents less than for owner operations at comparable levels of output. It should be noted, however, that comparable levels of output for "share-renters" and "owners" imply different sizes in terms of acres operated. For example, a 1,200-acre ranch on an owner-operator basis corresponds to an output of $242,400 (1,200 acres x $201.87 per acre); the same amount of output obtained on a share-rented basis corresponds to 1,554 acres--about one-fourth more acres. Part of the per unit cost difference between the owner and renter relates to the fact that the renter must operate a larger acreage to realize the same output (in dollars) and therefore is spreading his fixed costs over a larger acreage.

A 50 percent wage increase at present technology shifts the long-run cost curve for share-renters upward by about 14 percent compared to only a 10 percent shift for the owner-operator (compare T_o W_o and T_o W_1 in both Figures 7 and 8). The impact of a wage increase is greater on the renter than the owner-operator because a larger percentage of his total costs are hired labor costs. Assuming the use of labor-saving technology (for sugar beets and cotton) a 50 percent increase in wages for the share-renter results in a 10 percent increase in total costs--a saving of about 4 percent over costs incurred with current technology (compare T_1 W_1 and T_o W_1).

Similarly, with a 100 percent increase in wages and assuming no change in production practices, total costs for a renter increase by almost 30 percent. However, the introduction of certain labor-saving practices while doubling wages would increase total costs by only 18 percent (compare T_1 W_2 and T_o W_2 in Figure 8).

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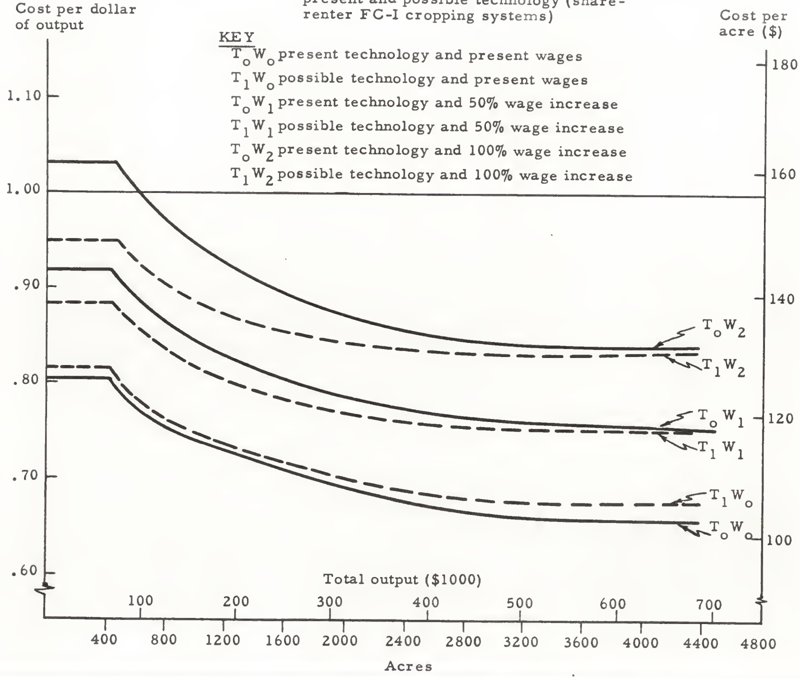
[1] Appendix Table A-1 shows the typical share rental percentages used in the analysis. Tenant gross returns for the cropping system assumed are given in Table 6.

Figure 8. Planning curves for three wage levels, present and possible technology (share-renter FC-I cropping systems)



The analysis of share-renting operations suggests the following conclusions: (1) new or beginning farmers can attain higher incomes by renting good land (if available in sufficient quantity) and investing their limited capital in machinery and productive expenses such as fertilizer and sprays, (2) increased wages have a greater immediate impact on renters than owners because wages account for a larger proportion of the renters total costs. Therefore, renters should be especially cognizant of any labor-saving practices that may offset possible wage increases.

Vegetable Crop Farms

Table 11 shows the typical machinery and equipment combinations for each of the five vegetable crop farm size groups. Based on survey information, farms of less than 160 acres are assumed to be operated by contract or custom machinery hire. In general, the investment for power equipment on vegetable crop farms is slightly less than for field crop farms. Typical machinery investmentsfor vegetable crop farms, based on 1959 costs, are about 80 percent as large as for field crop farms for Sizes II and III and about 60 percent as large for Sizes IV and V.

Harvesting operations were contracted on most of the vegetable crop farms surveyed, whereas harvesting operations on field crop farms were usually performed by a combination of owned and contract machinery. Of course, great variations exist in the quantity (number and capacity of machinery items) and quality (age and state of repair) of equipment found on farms--even on farms of the same size.

One cropping system is assumed for all sizes of vegetable crop farms (Table 12). Selection of a single typical cropping system for vegetable crop farms is admittedly an over-simplification. An examination of more than 200 Imperial Valley vegetable crop farms[1/] revealed wide variations in cropping systems. However, no systematic shift in cropping pattern by farm size was noted.[2/]

[1/] This list formed the basis for the sample of 48 vegetable crop farms used in the analysis.

[2/] In 1959, the Niland-Calipatria area contained a large number of small vegetable specialty crop farms (i.e., squash, tomatoes, cucumbers, etc.) which were not analyzed in this study.

TABLE 11

Typical Machinery Combinations for Vegetable Crop Farms of Various Sizes, Imperial County, 1959[a]

Type of Machine	Machinery combination for farm sizes[b]			
	II (160-640 acres)	III (640-1,200 acres)	IV (1,200-2,400 acres)	V (2,400 acres and more)
Automotive equipment:				
Pickups	2	2	3	4
Truck-flatbeds	1	2	3	3
Trailers	1	1	3	3
Wagons	1	1	3	3
Implement carryalls	1	1	1	2
Power equipment:				
Crawler tractors 50 CDB HP	-	-	1	2
75 CDB HP	1	1	1	2
100 CDB HP	-	1	1	1
Wheel tractors 20 CDB HP	1	1	-	-
30 CDB HP	2	2	3	5
40 CDB HP	-	1	2	4
Land preparation equipment:				
Chisel	1	1	2	2
Discs up to 8'	-	1	-	-
8' to 10'	-	-	1	1
10' to 14'	1	1	1	2
14' to 16'	-	1	1	1
Harrows - spike 12'	1	1	1	1
Harrows - spring 12'	-	1	1	1
Rollers 12'	1	1	1	2
Tool bars (wheel tractors)	2	3	4	6
Ditcher	1	1	1	1
Planting and cultivating equipment:				
Planters	1	2	3	4
Grain drills	1	1	1	1
Cultivators - 2 row	2	-	-	-
4 row	-	2	3	5
Sprayer - 300 gal.	1	1	1	1
Land leveling equipment:				
Landplanes - 12' x 60'	-	1	1	2
Scraper	1	1	1	1
Grader	-	1	1	1

a/ Sample of 49 vegetable crop farms; Imperial County, 1959.

b/ Size I (0-160 acres) operations are assumed to contract for all machine work.

TABLE 12

Cropping System Data Assumed for Vegetable Crop Farms

Crop	Unit	Yield per acre[a]	Price per unit[b]	Total revenue per acre	Percentage of acreage in rotation[c]	Owner-operated total revenue per acre of rotation	Share-renter total revenue per acre of rotation[d]
			dollars		percent	dollars	
Alfalfa	tons	6.00	26.00	164.00[e]	35	57.40	43.05
Barley	tons	1.75	45.00	78.75	20	15.75	11.75[f]
Cotton	bales	2.25	158.40	395.70[g]	15	59.36	47.48
Cottonseed	pounds	1,917	0.0205				
Lettuce	cartons	400	1.50	600.00	40	240.00	220.00
Cabbage	cartons	500	1.60	800.00	10	80.00	74.00
All crops	--	--	--	--	100	452.51	396.28

[a] For a complete list of yield assumptions used in the analysis, see Appendix Table A-3.

[b] For a complete list of price assumptions used for all crops considered in the analysis, see Appendix Table A-2.

[c] Overall averages based on sample of farms and adjusted to reflect a feasible individual farm rotation.

[d] Share-renter's gross income based on the typical share leasing or cash rent arrangements in Imperial County, See Appendix Table A-1.

[e] Includes $8.00 for winter pasturing.

[f] Barley is double cropped with lettuce and rent is estimated as the difference between lettuce-barley double cropped and lettuce single cropped, see Appendix Table A-1.

[g] Includes $39.30 for cottonseed.

The most common situation was where total acreage was split about evenly between field and vegetable crops. Therefore, for the analysis of vegetable crop farms, 50 percent of the acreage is assumed used for field crops (alfalfa, barley, and cotton) and the remaining 50 percent used for vegetable crops (lettuce and cabbage). Also, one-half of the acreage used for lettuce is assumed double-cropped with barley.

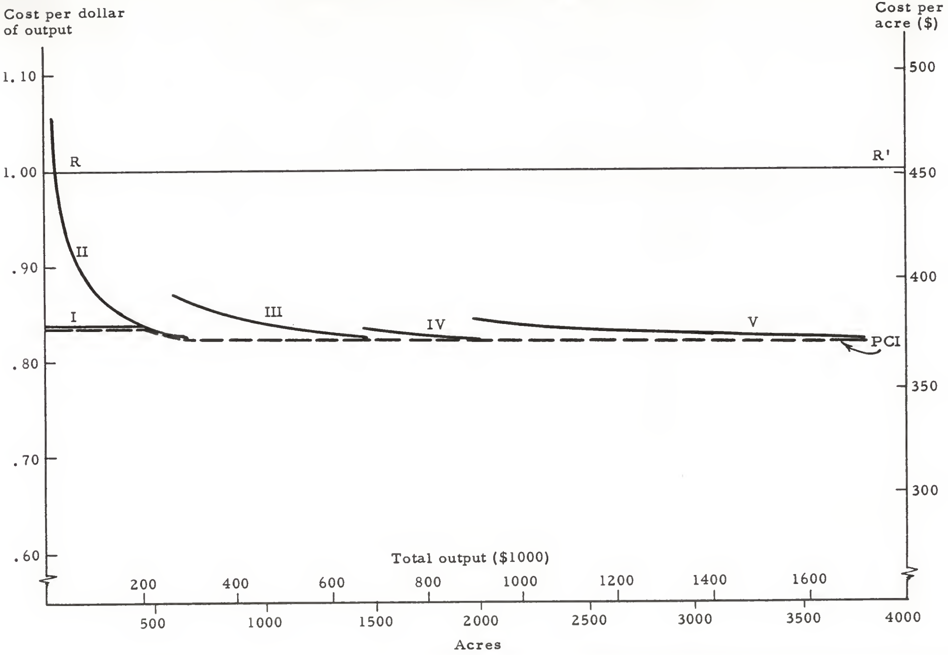
Cost Curves for all Inputs (Owner-Operator)

Following the procedure used for field crop farms, short-run average total cost curves are now constructed for each of the five "fixed" machinery combinations on vegetable crop farms (Figure 9). Again, total costs include all variable and fixed costs, including an opportunity cost on investment capital (i.e., 6 percent interest on the average machinery investment and on the land investment is considered the "cost" of employing this capital in agriculture rather than in some other alternative). Cost curve I is constructed on the basis that all machine operations are contracted, hence no machinery investment is included.

The planning curve for vegetable crop farms (PC-I in Figure 9) shows that if it is possible to obtain competent and timely contract work at rates assumed, there is little or no advantage in owning machinery. Cost curve I (based on all contract machine work) shows lower costs per unit of output than Size II (owned machinery) up to about 640 acres. Thereafter, only slight economies (lower costs) are realized as compared to the "contract" curve with each machinery size group when operating at or near capacity. Of course, in a situation where contract work is not readily available, considerable cost economies occur up to about 640 acres.

The apparent lack of any economies of scale on vegetable crop farms relates in part to the high proportion of contract harvest costs incurred in vegetable crop production. Table 13 shows, for example, the percentages of total variable costs related to cultural and harvesting activities for Size IV farms. A similar distribution of costs is evident for other size groups. Lettuce and cabbage, which together comprise 50 percent of the cropping system analyzed, have about 75 percent of the total variable costs associated with

Figure 9. Average total cost curves for each machinery combination and envelope or planning curve (owner-operator, vegetable crop farm)



harvesting. Harvesting lettuce and cabbage is primarily a labor intensive activity with minor machine costs. Thus, few machine economies can be realized on one-half of the cropping system.

TABLE 13

Distribution of Total Variable Costs Between Cultural and Harvest Activities for Size IV Farms

Crop	Distribution of total variable costs between:					
	Cultural		Harvest		Total	
	dollars	percent	dollars	percent	dollars	percent
Alfalfa	38.69	41.2	55.31	58.8	94.00	100
Barley	30.23	73.3	11.00	26.7	41.23	100
Cotton	118.17	46.5	135.89	53.5	254.06	100
Lettuce	111.18	24.6	340.00	75.4	451.18	100
Cabbage	99.36	17.3	475.00	82.7	574.36	100

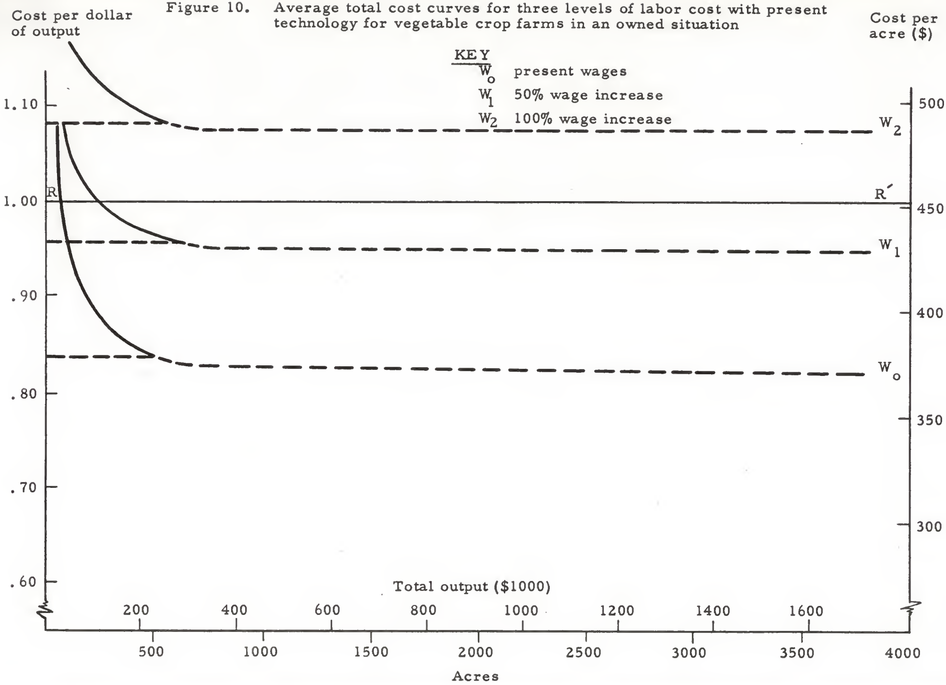
Effects of Wage Increases on Cost-Size Relationships

Figure 10 shows a comparison of planning curves (long-run average cost curves) for vegetable crop farms, assuming three different levels of wages. Curve W_o is identical to the planning curve shown in Figure 9 (PC-I). W_1 and W_2 are developed similarly assuming wage increases of 50 and 100 percent, respectively. These data indicate that a 50 percent wage increase on vegetable crop farms would cause, on the average, a 15 percent increase in total costs per dollar of output. A 100 percent increase in wages would result in a 30 percent in total costs and a negative profit or "management return" of 7.5 cents per dollar of output (or $33.40 per acre). However, with a 100 percent increase in wages, more "mechanized" crops or cropping practices would probably be incorporated into the operation.

Cost Structures for Rented Vegetable Farms

The preceeding analysis of vegetable farms was based on an owned operation. However, the farm survey indicated that about 75 percent of the acreage in

Figure 10. Average total cost curves for three levels of labor cost with present technology for vegetable crop farms in an owned situation



vegetable crop farms was rented. An analysis based on an entirely rented operation was therefore developed. The cost curves constructed were quite similar to those for the owner-operator presented in Figure 10; therefore, they are not reproduced here. Increases in wage rates by 50 percent and 100 percent also had a similar impact on costs in the owned and rented situation.

SUMMARY AND CONCLUSIONS

This report is primarily concerned with empirical measurement of cost-size relationship for two general types of cash crop farms--field crop and vegetable--in the Imperial Valley. Related questions are examined concerning the impact on farm size of increasing wage rates and possible changes in technology.

Personal interviews with a sample of 86 operators, supplemented with secondary engineering and cost data, provide the basis for the analysis. Although detailed results are provided in the text of this report, some of the more relevant findings are summarized as follows:

1. Substantial cost advantages are realized by field crop operations up to about 1,500-2,000 acres but thereafter costs economies are very slight. However, farms that are organized to operate large acreages but under utilize this capacity may have higher costs per acre than smaller farms operating more efficiently.

2. An increase in labor costs would have a material effect on total costs of field crop farms. On owned operations a 50 percent increase in wages would increase total costs by about 10 percent. Increased wages would have an even greater relative impact on renters than owners because labor costs account for a larger proportion of the renters' total costs. Substitution of possible labor-saving technology in the production of labor intensive crops such as sugar beets and cotton can offset some of the wage increases.

3. New or beginning farmers with limited capital would more profitably rent rather than buy land (if available in sufficient quantity) and invest their capital in machinery and other productive resources.

4. Assuming contract work is available for smaller operations, the long-run average costs for vegetable crop farms are relatively constant. When competent and timely contract work is available at current rates, there is little or no advantage to owning equipment.
5. A 50 percent wage increase for vegetable crop farms (as defined in the report) would cause about a 15 percent increase in total costs for the owner-operator.

APPENDIX:

Selected Basic Data

TABLE A-1

Most Common Leasing Arrangements in Imperial County Study Area

Crop	Share to landlord[a]	Cash rent	Share or cash rent used in analysis[b]
	percent	dollars	
Alfalfa	25-30	35-50	25%
Barley	25-33	20-45	25%
Sugar beets	17-1/2 - 25	35-60	20%
Cotton	20-25	40-60	20%
Flax	20-33	35-40	25%
Milo	25-30	30-45	25%
Lettuce - milo[c]		50-75	$70
Lettuce - barley[c]		50-75	$70
Lettuce only		50-55	$50
Cantaloupes[c]		50-70	$65
Carrots[c]		50-70	$60
Tomatoes		60-80	$70
Squash		60-80	$70
Cucumbers		60-80	$70
Onions		50-70	$60
Watermelons		70-75	$70
Asparagus		65	$65
Cabbage		40-60	$60

[a] Based on survey data from Imperial County farmers and on: Sample Costs, Cultural Practices, Miscellaneous Information Pertaining to Field Crops, Imperial County, 1958, Agr. Ext. Serv., El Centro, California; and Sample Costs, Cultural Practices, Miscellaneous Information Pertaining to Truck Crops, Imperial County, 1958, Agr. Ext. Serv., El Centro, California.

[b] Assumes landlord does no field work.

[c] Double crop.

TABLE A-2

Price Assumptions for Imperial County Crops[a]

Crop	Unit	Sugar content	Price per unit
		percent	dollars
Alfalfa	tons		26.00
Alfalfa seed	cwt.		21.00
Barley	tons		45.00
Sugar beets	tons	14.0	12.63
		15.0	13.41
		16.0	14.20
		16.2 (average)	14.39
		17.0	14.99
Cotton	bales		158.40
Cottonseed	lbs.		0.0205
Flax	bushels		2.90
Flax straw	tons		12.00
Milo	tons		46.00
Lettuce	cartons		1.50
Cantaloupes	crates		5.00
Cabbage	cartons		1.60
Carrots	crates		2.64
Tomatoes	crates		2.29
Squash	crates		2.03
Cucumbers	crates		1.55
Onions	sacks		1.44
Watermelons	tons		55.92

[a] Based on judgment and past prices received by Imperial County farmers.

TABLE A-3

Per Acre Yields and Fertilization Assumption for Imperial County Crops[a]

Crop	Unit	Yield	Fertilizer pounds	
Alfalfa[b]	tons	6.00	--	50 P_2O_5
Barley	tons	1.75	80 N	--
Sugar beets	tons	22.00	240 N	100 P_2O_5
	percent sugar	16.20		
Cotton	bales	2.25	180 N	75 P_2O_5
Flax	bushels	45.00	120 N	80 P_2O_5
Milo	tons	1.50	100 N	--
Lettuce	cartons	400.00	120 N	150 P_2O_5
Cantaloupes	crates	150.00	120 N	100 P_2O_5
Carrots	crates	300.00	120 N	150 P_2O_5
Tomatoes	flats	480.00	60 N	--
Cucumbers	crates	500.00	60 N	120 P_2O_5
Watermelons	tons	7.00	80 N	120 P_2O_5
Cabbage	cartons	500.00	140 N	80 P_2O_5

[a] All estimates based on Sample Costs, Cultural Practices, and Miscellaneous Information, Pertaining to Field Crops in Imperial County and Sample Costs, Cultural Practices, and Miscellaneous Information, Pertaining to Truck Crops in Imperial County, and adjusted on the basis of normal yields estimated by a sample of 85 Imperial County farmers in 1959.

[b] 50 pounds P_2O_5 for second and third year alfalfa, and 100 pounds P_2O_5 for first year alfalfa.

TABLE A-4

Tracklayer and Wheel Tractor Power Availability and Per Acre Crop Requirements by Time Periods, for Field Crop Farms[a]

Farm size, equipment, and time period		Per acre power requirement by crops and time periods[b]						Days available for field work [c]	Hours per day available [d]	Total hours per tractor available	Number of tractors [c]	Total tractor hours available
		Alfalfa hay	Cotton	Sugar beets	Flax	Barley (early)	Milo (late)					
Size II (320-640 acres):												
Tracklayer	Sept. - Oct.	.73	--	--	1.5	1.5	--	50	10	500	1	500
Wheel tractor	Jan. 1 - Feb. 15	--	--	.7	--	--	--	35	10	350	3	1,050
	Feb. 15 - Mar. 15	--	1.0	.3	--	--	--	22	10	220	3	660
	Mar. 15 - Apr. 15	--	1.6	.3	--	--	--	24	10	240	3	720
	Apr. 15 - Jun. 1	1.18	2.0	.7	--	--	--	39	10	390	3	1,170
	Jun. 1 - Jul. 15	1.18	.7	--	--	--	.2	39	10	390	3	1,170
	Jul. 15 - Aug. 15	.79	.7	--	--	--	--	24	10	240	3	720
	Aug. 15 - Sept. 15	.79	--	--	--	--	--	24	10	240	3	720
	Sept. 15 - Nov. 15	1.26	--	1.0	.2	.2	--	48	10	480	3	1,440
	Nov. 15 - Dec. 31	--	--	1.3	--	--	--	22	10	220	3	660
Harvesting												
Hay baling	Mar. 1 - Apr. 15	.083	--	--	--	--	--	25	4	100	1	100
	Apr. 15 - Jun. 1	.083	--	--	--	--	--	20	4	80	1	80
	Jun. 1 - Jun. 22	.083	--	--	--	--	--	16	4	64	1	64
	Jun. 22 - Jul. 21	.083	--	--	--	--	--	20	4	80	1	80
	Jul. 21 - Sept. 10	.083	--	--	--	--	--	25	4	100	1	100
	Sept. 10 - Oct. 31	.083	--	--	--	--	--	25	4	100	1	100
Size III (640-1,200 acres):												
Tracklayer	Sept. - Oct.	.73	--	--	1.5	1.5	--	50	10	500	2	1,000
Wheel tractor	Jan. 1 - Feb. 15	--	--	.4	--	--	--	35	10	350	4	1,400
	Feb. 15 - Mar. 15	--	.7	.2	--	--	--	22	10	220	4	880
	Mar. 15 - Apr. 15	--	.9	.2	--	--	--	24	10	240	4	960
	Apr. 15 - Jun. 1	1.18	1.2	.4	--	--	.2	39	10	390	4	1,560
	Jun. 1 - Jul. 15	1.18	.4	--	--	--	.2	39	10	390	4	1,560
	Jul. 15 - Aug. 15	.79	.4	--	--	--	--	24	10	240	4	960
	Aug. 15 - Sept. 15	.79	--	.2	.2	.2	--	24	10	240	4	960
	Sept. 15 - Nov. 15	1.26	--	.5	.2	.2	--	48	10	480	4	1,920
	Nov. 15 - Dec. 31	--	--	.8	--	--	--	22	10	220	4	880
Harvesting												
Hay baling	Mar. 1 - Apr. 15	.083	--	--	--	--	--	25	4	100	1	100
	Apr. 15 - Jun. 1	.083	--	--	--	--	--	20	4	80	1	80
	Jun. 1 - Jun. 22	.083	--	--	--	--	--	16	4	64	1	64
	Jun. 22 - Jul. 21	.083	--	--	--	--	--	20	4	80	1	80
	Jul. 21 - Sept. 10	.083	--	--	--	--	--	25	4	100	1	100
	Sept. 10 - Oct. 31	.083	--	--	--	--	--	25	4	100	1	100
Cotton picking	Sept. 1 - Oct. 25	--	1.4	--	--	--	--	45	10	450	1	450
Size IV (1,200-2,400 acres):												
Tracklayer	Sept. - Oct.	.73	--	--	1.5	1.5	--	50	10	500	4	2,000
Wheel tractor	Jan. 1 - Feb. 15	--	--	.4	--	--	--	35	10	350	6	2,100
	Feb. 15 - Mar. 15	--	.7	.2	--	--	--	22	10	220	6	1,320
	Mar. 15 - Apr. 15	--	.9	.2	--	--	--	24	10	240	6	1,440
	Apr. 15 - Jun. 1	1.18	1.2	.4	--	--	.2	39	10	390	6	2,340
	Jun. 1 - Jul. 15	1.18	.4	.75	--	--	.2	39	10	390	6	2,340
	Jul. 15 - Aug. 15	.79	.4	--	--	--	--	24	10	240	6	1,440
	Aug. 15 - Sept. 15	.79	--	.2	.2	.2	--	24	10	240	6	1,440
	Sept. 15 - Nov. 15	1.26	--	.5	.2	.2	--	48	10	480	6	2,880
	Nov. 15 - Dec. 31	--	--	.8	--	--	--	22	10	220	6	1,320
Harvesting												
Hay baling	Mar. 1 - Apr. 15	.083	--	--	--	--	--	25	4	100	2	200
	Apr. 15 - Jun. 1	.083	--	--	--	--	--	20	4	80	2	160
	Jun. 1 - Jun. 22	.083	--	--	--	--	--	16	4	64	2	128
	Jun. 22 - Jul. 21	.083	--	--	--	--	--	20	4	80	2	160
	Jul. 21 - Sept. 10	.083	--	--	--	--	--	25	4	100	2	200
	Sept. 10 - Oct. 31	.083	--	--	--	--	--	25	4	100	2	200
Cotton picking	Sept. 1 - Oct. 25	--	1.4	--	--	--	--	45	10	450	2	900
Size V (2,400 acres and more):												
Tracklayer	Sept. - Oct.	.73	--	--	1.5	1.5	--	50	10	500	7	3,500
Wheel tractor	Jan. 1 - Feb. 15	--	--	.4	--	--	--	35	10	350	9	3,150
	Feb. 15 - Mar. 15	--	.7	.2	--	--	--	22	10	220	9	1,980
	Mar. 15 - Apr. 15	--	.9	.2	--	--	--	24	10	240	9	2,160
	Apr. 15 - Jun. 1	1.18	1.2	.4	--	--	.2	39	10	390	9	3,510
	Jun. 1 - Jul. 15	1.18	.4	.75	--	--	.2	39	10	390	9	3,510
	Jul. 15 - Aug. 15	.79	.4	--	--	--	--	24	10	240	9	2,160
	Aug. 15 - Sept. 15	.79	--	.2	.2	.2	--	24	10	240	9	2,160
	Sept. 15 - Nov. 15	1.26	--	.5	.2	.2	--	48	10	480	9	4,320
	Nov. 15 - Dec. 31	--	--	.8	--	--	--	22	10	220	9	1,980
Harvesting												
Hay baling	Mar. 1 - Apr. 15	.083	--	--	--	--	--	25	4	100	3	300
	Apr. 15 - Jun. 1	.083	--	--	--	--	--	20	4	80	3	240
	Jun. 1 - Jun. 22	.083	--	--	--	--	--	16	4	64	3	192
	Jun. 22 - Jul. 21	.083	--	--	--	--	--	20	4	80	3	240
	Jul. 21 - Sept. 10	.083	--	--	--	--	--	25	4	100	3	300
	Sept. 10 - Oct. 31	.083	--	--	--	--	--	25	4	100	3	300
Cotton picking	Sept. 1 - Oct. 25	--	1.4	--	--	--	--	45	10	450	3	1,350

[a] Estimates for time periods for field operations for each crop were based on Sample Costs, Cultural Practices, and Miscellaneous Information Pertaining to Field Crops in Imperial County and the estimates of personnel in offices of the Farm Advisor and Agricultural Commissioner, Imperial County, California.

[b] Based on numerous California Extension Service publications pertaining to different crops; calculated on an engineering efficiency basis.

[c] Estimates include allowances for days when weather does not permit field operations.

[d] Based on the estimates of farmers for the hours of baling available on a normal night. All field operations based on a 10-hour day.

[e] See Table 5 for sizes of power equipment.

TABLE A-5

Summary of Owner-Operator Variable Costs and Returns Per Acre in Dollars for Each Crop Alternative, by Machinery Size Group, Field Crop Farms

Crop	Machinery size I			Machinery size II			Machinery size III			Machinery sizes IV & V		
	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/
	dollars per acre											
Alfalfa	164	99	65	164	68	96	164	68	96	164	68	96
Sugar beets	317	192	125	317	181	136	317	176	141	317	151	166
Cotton	396	270	126	396	261	135	396	175	221	396	174	222
Flax	136	75	61	136	66	70	136	66	70	136	65	71
Barley	79	48	31	79	42	37	79	41	38	79	40	39
Milo	69	46	23	69	40	29	69	40	29	69	39	30

a/ Gross return equals yield times price.

b/ "Variable cost" includes labor (at $1.60 per hour for tractor driving, $0.80 per hour for irrigation and unskilled labor), fuel, oil, seed, fertilizer, and other direct production expenses. Does not include any "fixed costs" such as depreciation or interest.

c/ Net return = gross return - variable cost. Fixed costs have not been subtracted.

TABLE A-6

Summary of Owner-Operator Variable Cost and Returns Per Acre in Dollars for Each Crop Alternative, by Machinery Size Group, Vegetable Crop Farms

Crop	Machinery size I			Machinery size II			Machinery size III			Machinery sizes IV & V		
	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/	Gross return a/	Variable cost b/	Net return c/
	dollars per acre											
Alfalfa	164	99	65	164	96	68	164	94	70	164	94	70
Sugar beets	317	192	125	317	182	135	317	176	141	317	176	141
Cotton	396	270	126	396	262	134	396	255	141	396	254	142
Barley	79	48	31	79	42	37	79	42	37	79	41	38
Milo	69	46	23	69	46	23	69	41	28	69	40	29
Lettuce	600	471	129	600	458	142	600	452	148	600	451	149
Cabbage	800	598	202	800	583	217	800	575	225	800	574	226
Cantaloupe	750	582	168	750	569	181	750	563	187	750	562	188

a/ Gross return equals price times yield.

b/ "Variable cost" includes labor (at $1.60 per hour for tractor driving, $0.80 per hour for irrigation and unskilled labor), fuel, oil, seed, fertilizer, and other direct production expenses. Fixed costs such as depreciation or interest are not included.

c/ Net return = gross return - variable cost.